The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JEROME H. LUDWIG

Appeal No. 2005-1020
Application No. 09/410,916

ON BRIEF

Before WALTZ, TIMM, and DELMENDO, Administrative Patent Judges.

DELMENDO, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 (2004) from the examiner's final rejection of claims 23 through 31 (final Office action mailed Apr. 7, 2003), which are all of the claims pending in the above-identified application.

The subject matter on appeal relates to a method for steam sterilizing a fire sprinkler system. Further details of this appealed subject matter are recited in representative claim 23, the sole independent claim on appeal, reproduced below:

> 23. A method for steam sterilizing a fire sprinkler system comprising

isolating a section of a water distribution pipe in a fire sprinkler system for the delivery of steam, wherein said water distribution pipe includes a plurality of heat-sensitive sprinkler heads and contains water,

removing the water from said section of the system,

utilizing a temperature sensor to detect the temperature at a position in said section of the system,

inactivating the sprinkler heads during the delivery of the steam by removing said sprinkler heads and replacing them with temporary fittings,

delivering said steam into said section for a duration at a temperature and in an amount sufficient to kill microorganisms and sterilize the section, and

returning said sterilized section in the system to operation.

The examiner relies on the following prior art references as evidence of unpatentability:

Singh	5,512,249	Apr. 30, 1996
Ludwig et al. (Ludwig)	6,076,536	Jun. 20, 2000 (filed Oct. 07, 1998)

Claims 23 through 31 on appeal stand rejected under 35 U.S.C. § 103(a) as unpatentable over Ludwig in view of Singh. (Examiner's answer mailed on Dec. 16, 2003, pages 3-5.)

We reverse this rejection for essentially the reasons set forth in the appeal brief filed on Oct. 3, 2003 and the reply brief filed on Feb. 17, 2004.

Ludwig, the principal prior art reference, teaches a method of chemically cleaning and rapidly passivating a water

distribution system, such as a fire protection system. (Column 2, lines 25-30.) Specifically, Ludwig discloses an embodiment in which a section of the water distribution system is isolated and a chemical cleaning solution, preferably an aqueous solution, is added to the section.[1] (Column 2, lines 31-34.) According to Ludwig, "[t]he aqueous chemical cleaning solution may be heated to a temperature in the range of about 10° C. to about 80° C. over the system water temperature before it is introduced into the section." (Column 2, lines 34-37.) Ludwig further teaches (column 2, lines 37-57):

> After a sufficient time, the cleaning solution containing the solubilized, loosened or suspended scale and sediment is removed from the section. Removal may be accomplished by flushing the section with passivated water, by using air to evacuate the system, or by decanting the spent solution. Immediately, an effective concentration of passivating agent in aqueous solution is added to the section. The passivating agent may be, for example, solutions of phosphates, orthophosphates, polyphosphates, zinc compounds, silicates, carbonates, or combinations of these and may be adjusted to a pH that is optimal for the particular passivating agent selected. The passivating agent, at a concentration in the range of about 25 ppm to about 20,000 ppm, is maintained in the section for about 15 to about 120 minutes. In a

[1] Ludwig states that when the fire protection system is a fire sprinkler system, the sprinkler head is first removed and the system is connected via a manifold connected to a mobile recirculating unit as described in United States Patent 5,680,877 issued to Edstrand et al. on Oct. 28, 1997, copy attached. (Column 5, lines 20-27.)

> preferred embodiment, the passivating solution is recirculated throughout the section, but may also be surged through the section or maintained in static contact with the section. The passivating solution is then flushed from the section with water, preferably containing a lower maintenance concentration of the same passivating agent.

In yet another embodiment, Ludwig teaches that a biocide may be added during passivation. (Column 4, lines 12-18.)

Singh, the other relied upon prior art reference, teaches an apparatus for sterilizing a transfer conduit (such as those used in the pharmaceutical and biotech industries) comprising:

(a) a source of steam connected to said transfer conduit;

(b) a condensate conduit for draining steam condensate from said transfer conduit;

(c) a valve in said condensate conduit comprising a valve body having an upstream portion and a downstream portion, said portions separated by a rapidly opening flow control means;

(d) a temperature sensor in said upstream portion of said valve body; and

(e) a temperature controller connected to said temperature sensor adapted to read the temperature in the upstream portion of the valve body and to open said valve when the temperature drops below a fixed set point and to

close said valve when the temperature is above the fixed set point. (Column 1, lines 5-10 and 50-67.)

In support of the rejection, the examiner states (answer at 4):

> Then, Ludwig teaches of [sic] delivering sterilant heated in the range of 10 degree [sic] Celsius to 80 degree [sic] Celsius over the water [temperature] in the system, which depending on the temperature of the water in the system may intrinsically includes [sic] steam, for a duration to kill microorganisms in the isolated section (col.3, lines 42-48). Then, Ludwig returns the passivated section to operation (col.5, lines 15-19). However, Ludwig fails to disclose the explicit use of steam and the use of a temperature sensor. Singh teaches of [sic] sterilizing the interior surfaces of conduits by using steam (col.3, lines 61-67 and col.4, lines 1-9). Furthermore, Singh discloses the use of a temperature sensor (figure 1, 23 and col.3, lines 15-21). It would have been obvious to one having ordinary skill in the art to modify the method of Ludwig by substituting one type of sterilant (heated liquid sterilant) by another (steam) since steam is a well known sterilant in the art of sterilization. [Emphasis added.]

We cannot agree. While the examiner alleges that the aqueous chemical cleaning solution "may intrinsically" include steam, this allegation is, at best, speculative and, at worst, incorrect. Under basic thermodynamics principles, liquid water does not transform to vapor at 212°F at pressures higher than atmospheric pressure. Elevated temperatures are required. (See Saturated Steam Tables, at

http://www.massengineers.com/Documents/Saturated steam tables.htm (Oct. 13, 2004), copy attached. Moreover, Ludwig requires a passivation solution, to which may be added a biocide. Nothing in the applied prior art references indicates that a gas may be added and maintained with a passivation solution.[2]

Singh is of no help to the examiner. The examiner does not adequately explain why one of ordinary skill in the art (i.e., the fire sprinkler system cleaning art) would have been led to use steam as shown in Singh, which relates to a sterilizing apparatus useful in the pharmaceutical and biotech industries, in direct conflict with the principles of operation described in Ludwig. Where multiple prior art references are combined to arrive at the claimed subject matter, the examiner must point to some motivation, teaching, or suggestion in the prior art themselves that would have led one of ordinary skill in the art to make the proposed combination. In re Dembiczak, 175 F.3d

[2] The examiner further alleges (answer at 4): "Ludwig teaches of, [sic] purging the sterilant with gas and also teaches that water can be used...since Ludwig is using biocides to insure the sterility of the treated section, then it is intrinsic for Ludwig method [sic] to use sterile gas as well as sterilized water." As correctly noted by the appellant (appeal brief at 7), it is not "intrinsic" in Ludwig that sterile gas or sterile water is used.

994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999)("T]he best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references."); In re Warner, 397 F.2d 1011, 1016, 154 USPQ 173, 177 (CCPA 1967)("W]here the invention sought to be patented resides in a combination of old elements, the proper inquiry is whether bringing them together was obvious and not, whether one of ordinary skill, having the invention before him, would find it obvious through hindsight to construct the invention from elements of the prior art.").

Because the examiner has not discharged the initial burden of establishing a prima facie case of obviousness, we cannot affirm. In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992); In re Piasecki, 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984).

In sum, we reverse the examiner's rejection under 35 U.S.C. § 103(a) of appealed claims 23 through 31 as unpatentable over Ludwig in view of Singh.

The decision of the examiner is reversed.

REVERSED

Thomas A. Waltz Administrative Patent Judge	
Catherine Timm Administrative Patent Judge	BOARD OF PATENT APPEALS AND INTERFERENCES
Romulo H. Delmendo Administrative Patent Judge	

RHD/gjh

WOOD HERRON & EVANS LLP
2700 CAREW TOWER
441 VINE ST
CINCINNATI OH 45202

US005680877A

United States Patent [19]

Edstrand et al.

[11] Patent Number: 5,680,877

[45] Date of Patent: Oct. 28, 1997

[54] **SYSTEM FOR AND METHOD OF CLEANING WATER DISTRIBUTION PIPES**

[75] Inventors: **Craig Edstrand; Myron Shenkiryk**, both of Phoenix, Ariz.

[73] Assignee: **H.E.R.C. Products Incorporated**, Phoenix, Ariz.

[21] Appl. No.: 547,099

[22] Filed: Oct. 23, 1995

[51] Int. Cl.[6] B08B 9/06

[52] U.S. Cl. .... 134/103.1; 134/169 C; 134/166 C

[58] Field of Search .... 134/103.1, 166 C, 134/169 C, 167 C, 166 R, 168 R, 169 R, 22.12

[56] **References Cited**

U.S. PATENT DOCUMENTS

1,892,093	12/1932	Battistella .
3,667,487	6/1972	Schoenbeck et al. .
5,360,488	11/1994	Hieatt et al. .

Primary Examiner—Frankie L. Stinson

Attorney, Agent, or Firm—Wood, Herron and Evans, L.L.P.

[57] **ABSTRACT**

A method of and system for cleaning and maintaining water distribution pipes which have reduced flow due to an increase of water scale deposits, sediment and the like along the inside surface of the pipe includes a mobile cleaning unit which can be conveniently and easily connected to a pipe section to be cleaned. An aqueous cleaning solution is introduced and circulated in a first direction through the pipe section for sufficient time to dissolve and loosen scale and sediment. The flow direction of the treating solution is then reversed to break off or remove sediment or other tuberculated growth that has developed directionally with the direction of water flow in the pipe section. The turbulent flow in the opposite direction increases the effectiveness of the cleaning process in particularly troublesome and hard-to-clean pipe sections. The spent treating solution and other deposits are flushed from the pipe and the mobile cleaning unit to an appropriate waste stream. Advantageously, the direction of the flow of the treating solution can be reversed without disconnecting the cleaning unit from the pipe section.

16 Claims, 3 Drawing Sheets

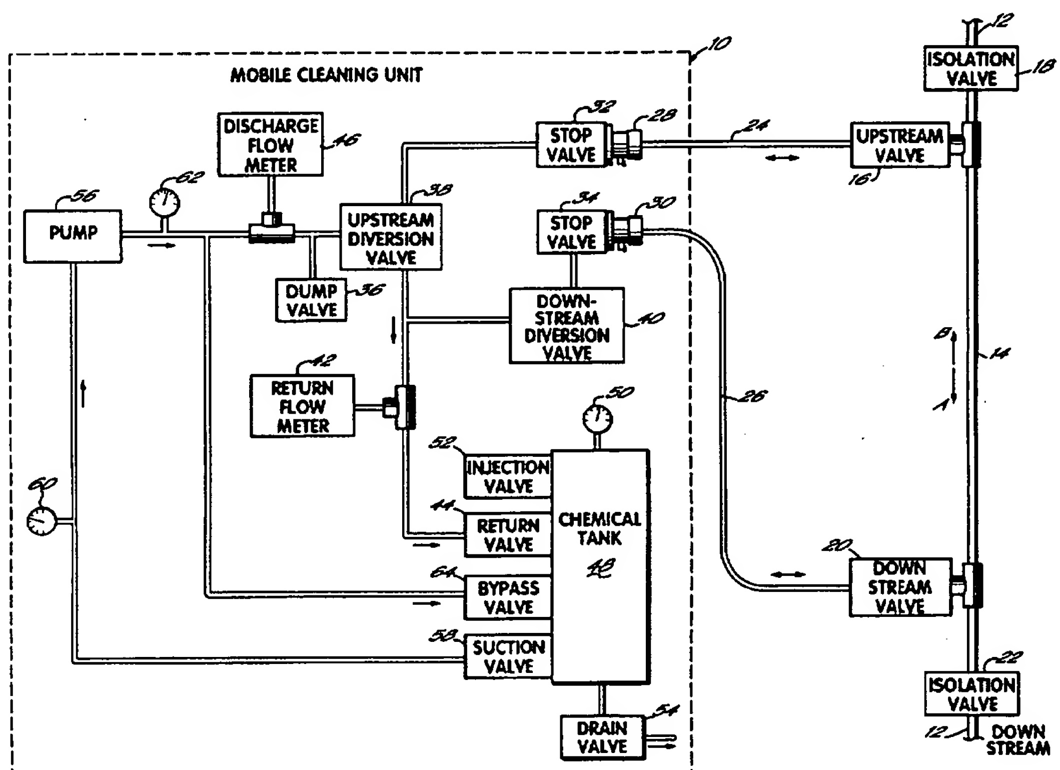
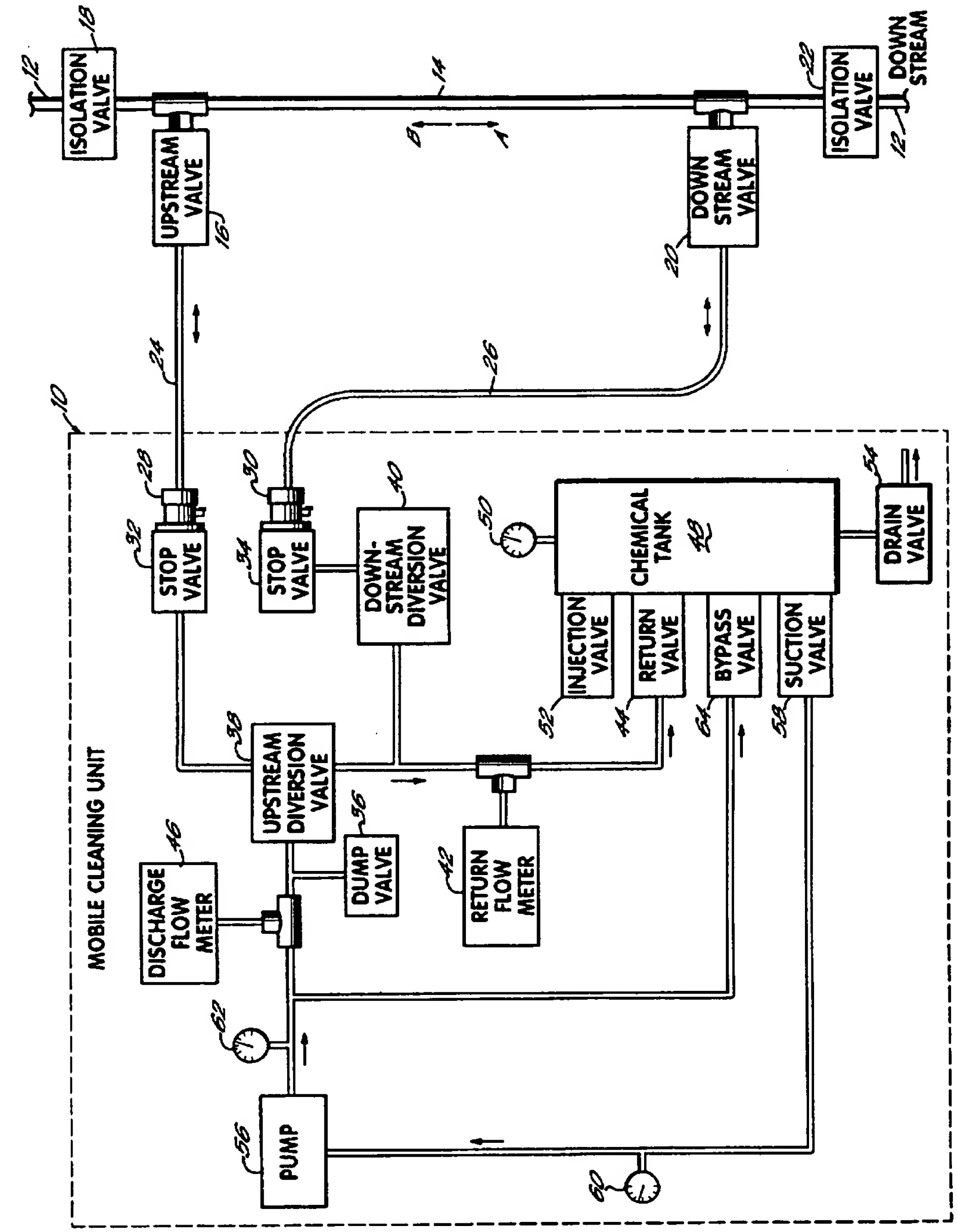


FIG. 1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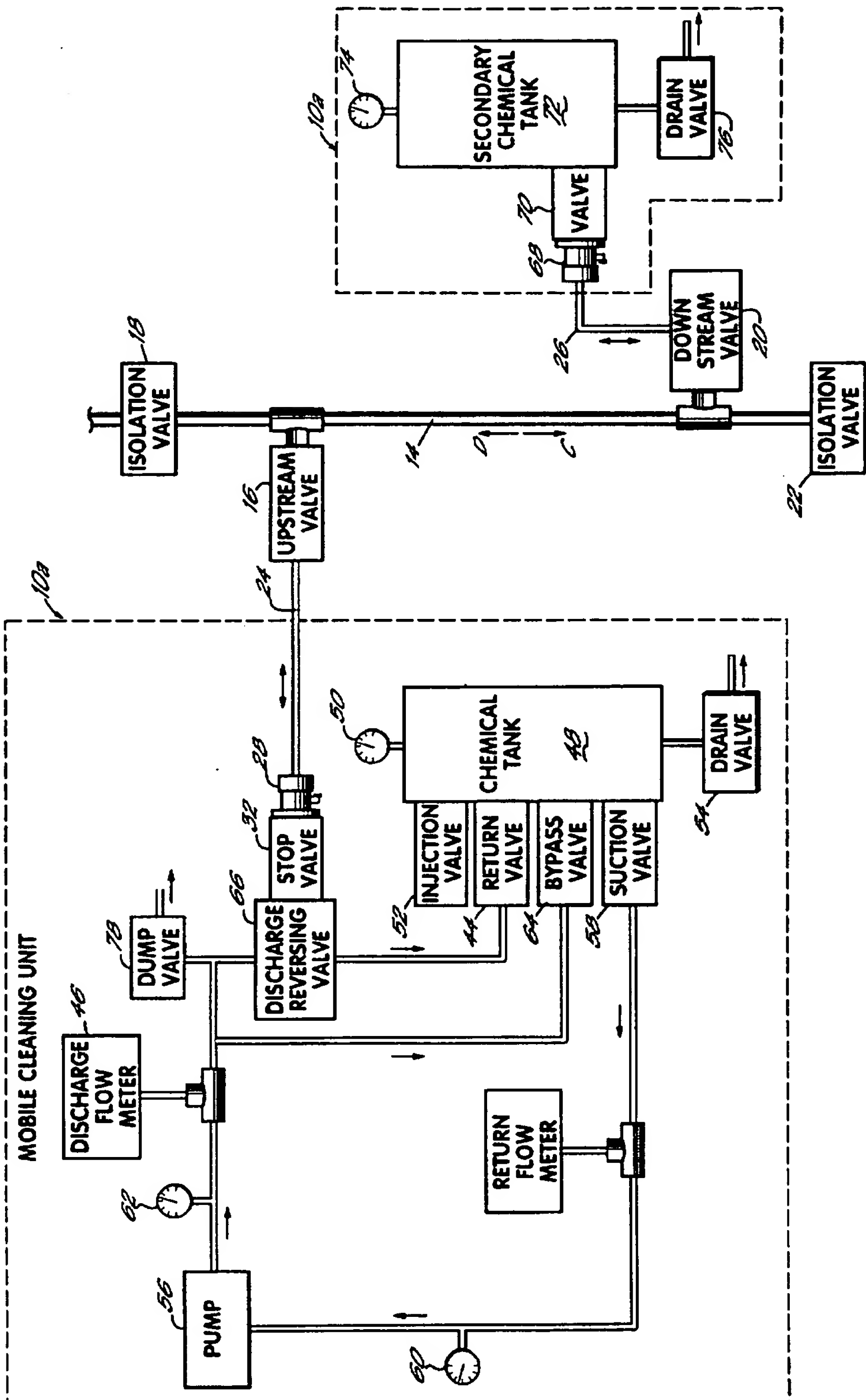
UPSTREAM VALVE
DOWN STREAM VALVE
DOWN STREAM
MOBILE CLEANING UNIT
STOP VALVE
STOP VALVE
DOWN-STREAM DIVERSION VALVE
CHEMICAL TANK
DRAIN VALVE
INJECTION VALVE
RETURN VALVE
BYPASS VALVE
SUCTION VALVE
UPSTREAM DIVERSION VALVE
DUMP VALVE
RETURN FLOW METER
DISCHARGE FLOW METER
PUMP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SECONDARY CHEMICAL TANK
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VALVE
DOWN STREAM VALVE
ISOLATION VALVE
UPSTREAM VALVE
ISOLATION VALVE
DOWN STREAM
CHEMICAL TANK
DRAIN VALVE
INJECTION VALVE
RETURN VALVE
BYPASS VALVE
SUCTION VALVE
STOP VALVE
DISCHARGE REVERSING VALVE
DUMP VALVE
DISCHARGE FLOW METER
RETURN FLOW METER
PUMP
10a
74
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76
70
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FIG. 2

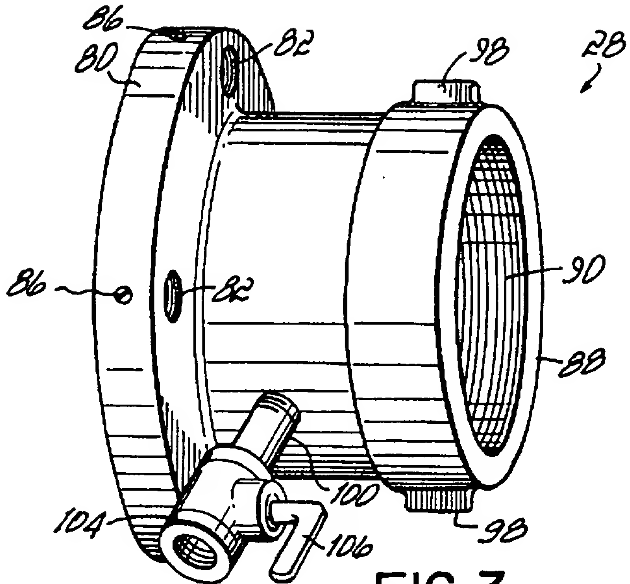

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FIG. 3

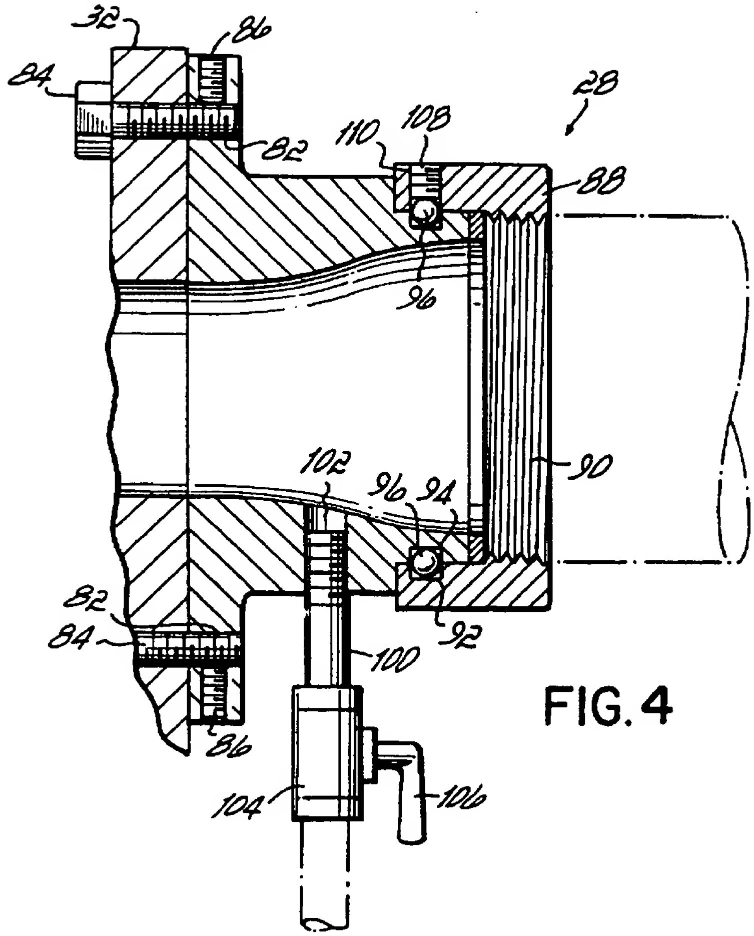

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FIG. 4

SYSTEM FOR AND METHOD OF CLEANING WATER DISTRIBUTION PIPES

BACKGROUND OF THE INVENTION

It is well known that the hardness of and suspended solids in the water of commercial, residential and industrial water sources vary widely depending on the source and will result in scale deposition and sedimentation on surfaces wherever the water is used. Scale deposition and sedimentation are particularly troublesome in water distribution pipe systems which service the residential and commercial customers of municipalities, private water companies and the like along with industrial process water distribution pipe systems or networks as found in mining, petroleum, agricultural and the like industries. In such water distribution systems, the formation of scale and sediment can reduce the water flow through the pipe system which will limit the capacity of the pipe to service the requirements of the customers or to provide the required water necessary for an industrial process, irrigation, or the like. For instance, an increased fire hazard would result if the fire hydrants connected to a municipal water system did not supply sufficient water to extinguish the fire due to scale and sediment deposits in the feed pipe line. Ultimately, the water distribution pipe would have to be replaced due to the restrictions created by the scale and sediment deposits which is very costly and entails a prolonged interruption of service.

Additionally, scale and sedimentation will increase the possibility of corrosion in the water distribution pipe along with promoting the growth of bacteria and other organisms. Bacteria and other organisms can be a health hazard and promote corrosion and bio-mass which bind scale and sediment together on the surfaces of the pipes in the system. Corrosion eventually leads to leakage of the pipes in the system and the necessity to replace the leaking sections.

Strong acids have been used to clean water wells; however, submersible pumps in the wells have to be removed prior to treatment to prevent corrosion by the acids employed during the cleaning process. Also, organic acids, mixtures of mineral acids and other compositions have been found to clean water wells without the necessity of removing the pumps or other equipment. These methods for cleaning water wells have involved static and surging treatment.

A proper cleaning and maintenance program for water distribution systems will prevent decreased water flow capacity, corrosion and the necessity to replace the system or portions thereof. One method for cleaning water distribution pipes is disclosed in U.S. Pat. No. 5,360,488 which is assigned to the assignee of this invention and hereby incorporated by reference. The method disclosed in that patent includes introducing an aqueous acidic cleaning solution into a pipe section to be treated and circulating the cleaning solution for a sufficient time to dissolve and loosen the scale and sediment. The spent treating solution containing the dissolved and suspended scale and sediment is then flushed from the pipe section to provide a cleaned pipe with improved water flow.

While the method disclosed in U.S. Pat. No. 5,360,488 has proven to be adequate for many applications, the cleaning effectiveness of that method is minimized in pipes which have an excessively large amount of scale deposits, sediment and the like on the inside of the pipe. Typically, in normal operation water flows in a single direction through a particular pipe section. As a result, tuberculated growth, scale deposits and other sediment inside the pipe develops and accumulates directionally with the direction of water flow in the pipe section. As a result, the cleaning of such pipe sections is particularly difficult and known methods are often ineffective for cleaning and maintaining these systems.

SUMMARY OF THE INVENTION

It has been a primary objective of this invention to provide an effective system and method for cleaning water distribution pipes having scale and sediment deposits therein.

It has been a further objective of this invention to provide such a method and system which is effective for cleaning particularly troublesome deposits and sediment that had developed directionally inside the pipes with the direction of water flow therein.

A still further objective of this invention has been to provide such a method and system which can be easily and efficiently utilized with a minimal amount of labor and out of service time for the pipe section.

It has been a still further objective of this invention to provide such a system in which the major components consist of acid resistant materials which are capable of circulating treating solution for the pipe section over extended periods of time without degradation or failure.

These and other objectives of the invention are achieved by a system for and method of cleaning and maintaining water distribution systems. Such systems having interior scale, sediment deposits and tuberculated growth which may have developed directionally with the direction of water flow in the system are cleaned by introducing an effective amount of an aqueous treating solution into the pipe section to be cleaned and circulating the treating solution in a first direction through the cleaning unit and pipe section. Thereafter, the treating solution is circulated in the pipe section in another direction opposite to the first direction within the pipe section. When the treating solution flow is reversed periodically during the cleaning process, the tuberculated nodules, sediment and other deposits which have formed as a result of water flowing in a single direction through the pipe in use are removed or broken off due to the more turbulent flow in the opposite direction from the flow in which they were formed. Further, periodically reversing the flow of the treating solution enhances the cleaning process by loosening the nodules and deposits and exposing previously unexposed portions thereof which otherwise could not be accessed by flow of the treating solution in a single direction. As a result, water distribution pipes with particularly large sediment deposits or other growth which previously have proven to be particularly troublesome are effectively unclogged and cleaned according to this invention.

Preferably, the system of this invention for cleaning water distribution pipes can be used to reverse the flow of the treating solution within a pipe section to be cleaned without detaching or disconnecting the system from the pipe section. The invention is preferably a closed system for cleaning the pipe section. According to presently preferred embodiments of the invention, diversion valves are provided in the cleaning unit which can be easily reconfigured between discharge and return configurations in order to reverse the flow of the treating solution within the pipe section to be cleaned without disconnecting or removing the cleaning system from the water distribution pipe.

Moreover, major components of this system are fabricated from chemical resistant materials to be able to circulate an appropriate treating solution for extended periods of time including solutions having a pH of approximately zero to fourteen. Further, a presently preferred flanged swivel

adapter is included in the system to minimize threaded connections between various components of the system which may be eroded over time by the treating solution. Moreover, the flanged swivel adapter includes a bleed line by which a portion of the solution circulating through the adapter in the system can be bled off and sampled to monitor the pH and other parameters of the treating solution during the cleaning process without interrupting the cleaning process.

The treating solution may be acidic, neutral or basic. In a presently preferred form, mineral acids or organic acids and mixtures thereof are employed as acidic treating solutions. The treating solutions may contain further additives such as inhibitors, chelating agents, penetrating and/or disbursing agents to assist in the removal of scale and sediment and to minimize any adverse effects of the pipes, valves and other system surfaces due to the treating solution employed.

Once the treating solution has been appropriately neutralized, the fluid in the cleaning unit along with the dissolved or suspended scale, sediment and other removed tuberculated growth nodules from the pipe section are flushed from the water distribution system and cleaning unit for appropriate disposal.

This invention provides a simple, low cost, and effective method for removing scale, sediment, and particulate growth which has developed directionally with the direction of water flow within the pipe section in order to maintain proper water flow, operation and to prevent corrosion of the system which could lead to the high cost and inconvenience of replacement. Further, the cleaning process is effective for particularly troublesome applications with a minimal amount of out of service time for the water distribution system and inconvenience by the operators in monitoring and adjusting the components of the system for an effective cleaning process. Further, components of the system are made of chemical resistant materials and designs of construction employed enable use of effective treating solutions for extended periods of time without degradation or failure of the components.

BRIEF DESCRIPTION OF THE DRAWINGS

The objectives and features of the invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic representation of a first presently preferred embodiment of the system for cleaning a pipe section for the water distribution network;

FIG. 2 is a second presently preferred embodiment of such a system;

FIG. 3 is a perspective view of a presently preferred embodiment of a flanged swivel adapter which is used in the cleaning system of this invention; and

FIG. 4 is a cross-sectional view of the adapter shown in FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a first presently preferred embodiment of a mobile cleaning unit **10** water distribution pipe network **12** is shown. The components of a mobile cleaning unit **10** are shown contained in the dashed lines of FIG. **1** and are preferably mounted upon a flatbed truck (not shown) or the like for convenient transportation and positioning of the mobile cleaning unit **10** proximate a pipe section **14** to be cleaned of the water distribution network **12**. A 36×8 foot flatbed goose neck trailer or other comparable vehicle is appropriate to mount the components of the mobile cleaning unit **10** according to this invention. The cleaning unit **10** is positioned at an upstream valve **16** such as a hydrant, tap or the like at an upstream end of the pipe section **14**. Upstream of the upstream valve **16** in the water distribution network **12** is an isolation valve **18** which when opened for normal use permits water in the distribution network **12** to flow through the pipe section **14** and when closed isolates the pipe section **14** and blocks water from flowing therein. The pipe section **14** extends between the upstream valve **16** and a downstream valve **20** such as a hydrant, tap or the like, which is positioned upstream from a downstream isolation valve **22** of the water distribution network **12**. Typically, the pipe section **14** to be cleaned is approximately a 1200 feet long section of a 6 inch water distribution pipe.

The mobile cleaning unit **10** is initially positioned proximate the upstream valve **16** and an upstream circulation hose **24** is connected to the upstream valve **16** and unwound from a hose reel (not shown) while moving the mobile cleaning unit **10** downstream to approximately the midpoint of the pipe section **14** to be cleaned. The unwound upstream circulation hose **24** is then disconnected from the hose reel on the mobile cleaning unit **10** and the unit **10** is moved to the downstream valve **20**. A downstream circulation hose **26** is then connected to the downstream valve **20** and unwound from a hose reel (not shown) while moving the mobile cleaning unit **10** to approximately the midpoint of the pipe section **14**. The hose reel assemblies include a disk, drum, axle, self-lining bearings, 12 volt rewind mechanism, motor and frame and are commercially available from Hannay Reels as Model No. EC2645-52VER G. The downstream unwound hose **26** is disconnected from the hose reel and the free ends of the upstream and downstream circulation hoses **24**, **26** are connected to upstream and downstream flanged swivel adapters **28**, **30**, respectively. Each of the adapters **28**, **30** are connected to a stop valve **32**, **34**, respectively. The flanged swivel adapters **28**, **30** will be described in detail later herein with reference specifically to FIGS. **3** and **4**. The stop valves **32**, **34** are each operable between an open and a closed position to permit and prevent, respectively, flow therethrough. The circulation hoses **24**, **26** are preferably 100% polyester mill 4 inch discharge hoses, single jacketed with firehose couplings. Such hoses are manufactured by the National Firehose Corporation and approximately 1,200 feet of hose is required for this example of this invention. Within the mobile cleaning unit **10**, the various components as described herein are connected by piping, preferably 2, 3 or 4 inch polypropylene schedule **80** pipe with socket fusion couplings.

The downstream stop valve **34** is connected to a dump valve **36** for purging fluid at this point in the mobile cleaning unit **10**. The upstream and downstream stop valves **32**, **34** are connected to upstream and downstream diversion valves, **38** and **40**, respectively. The upstream diversion valve **38** is adjustable between a return flow position from the upstream direction of the pipe network **12** to the mobile cleaning unit **10** and a discharge position from the mobile cleaning unit **10** to the pipe section **14** to be cleaned. Similarly, the downstream diversion valve **40** is operable between a return flow position from the downstream direction of the pipe section **14** to be cleaned and a discharge position from the mobile cleaning unit **10** to the pipe section **14**. Preferably, the diversion valves **38**, **40** are each three way 3 inch valves with wrench and lock-out capabilities. Such a valve is available from Xomox Corporation as Part No. 031 AX DI/PFA.

The downstream diversion valve 40 of the mobile cleaning unit 10 is connected by piping through a return flow meter 42 to a return valve 44. The upstream diversion valve 38 is connected via piping to a discharge flow meter 46. Each of the flow meters 42, 46 are preferably 3 inch, polyurethane lined, remote type flow meters commercially available from Admag as Model No. AM11 DHD1A and preferably include flow meter sensors (Model No. AM208DN).

The return valve 44 is mounted on a chemical tank 48 which is preferably a 3,000 gallon steel tank measuring approximately 61×96×120 inches having welded baffles and an 18 inch diameter opening. Preferably, the interior of the chemical tank 48 is coated with vinyl ester (TNEMEC, Series 120 Vinester) and the exterior with polyurethane enamel to resist chemical corrosion and degradation of the tank 48 from both the chemicals contained therein and exterior environmental conditions. The tank 48 preferably includes a level indicator 50 which is a two wire, loop powered level measuring ultrasonic transmitter with display operating at 30 kilohertz which is commercially available from Hawk America (Sensor Model No. TD30-06). An injection valve 52 is also coupled to the chemical tank 48 for injecting treating solution and other aqueous based fluids into the chemical tank 48. A drain valve 54 is also provided proximate the bottom of the tank 48 for the discharge of sediment, particulate matter and fluids which remain in the tank 48 after the cleaning process.

A pump 56 is connected via appropriate piping to the chemical tank 48 through a suction valve 58. A suction pressure gauge 60 is provided between the pump 56 and the suction valve 58 on the chemical tank 48. The pump 56 is preferably a horizontal centrifugal pump, glass reinforced vinyl ester construction having a 2.3 liter 63 horsepower Ford industrial gas engine with electric starter. The pump 56 is commercially available from Ingersoll Dresser as Model No. GRP4×3×10 and the engine from Ford as Model No. LSG4231-6007-B, Model Code AX991-02. Output from the pump 56 is directed via piping to the discharge flow meter 46. A discharge pressure gauge 62 is provided at the discharge side of the pump 56. A bypass line connected to a bypass valve 64 on the chemical tank 48 is coupled directly to the pipe exiting the pump 56.

Preferably, each of the valves of the mobile cleaning unit are 1, 2, 3 or 4 inch ball valves of solid graphite construction having an insert constructed with fibers and Ryton. Valves of this type are commercially manufactured by Dresser as NIL-COR-X-310-ST-T-S. In addition, the mobile cleaning unit 10 preferably includes additional water storage tanks (not shown) each having 230 gallon capacity and being polyethylene horizontal leg tanks commercially available from Snyder.

The process for cleaning the pipe section 14 with the mobile cleaning unit 10 according to the presently preferred embodiment shown in FIG. 1 begins with charging the mobile cleaning unit 10 with water from the water distribution network 12 after the upstream and downstream circulation hoses 24, 26 are connected as previously described. To charge the cleaning unit 10 with water, the injection valve 52, drain valve 54 and connected dump valve 36 are closed. The return and suction valves 44, 58 on the chemical tank 48 and the upstream stop valve 32 are all opened and the upstream diversion valve 38 is positioned for return flow from the upstream direction of the water distribution network 12 and the downstream diversion valve 40 is positioned for return flow from the downstream direction and into the cleaning unit 10 from the water distribution network

12. The upstream valve 16 and upstream isolation valve 18 are opened allowing water from the distribution network 12 to flow through the upstream circulation hose 24 and into the mobile cleaning unit valves and piping components and into the chemical tank 48. Once the air in the upstream portion of the mobile cleaning unit 10 is displaced from the piping, valves, and associated components, the upstream stop valve 32 is closed and the downstream valve 20 and stop valve 34 are opened permitting water to flow through the pipe section 14 to be cleaned, displacing the air and filling the downstream circulation hose 26 and flowing through the downstream portion of the mobile cleaning unit valves and piping and into the chemical tank 48. This flow is continued until the desired water level in the chemical tank 48 is achieved and the piping system within the cleaning unit 10 and the pump 56 are full of water at which time the downstream stop valve 34 is closed.

After the cleaning unit 10 is charged with water, the cleaning unit 10 and pipe section 14 to be cleaned are isolated from the network 12 and checked for leaks as follows. The upstream and downstream isolation valves 18, 22 are closed and the upstream diversion valve 38 is positioned as discharge from the cleaning unit 10 to the pipe section 14. The pump 56 is started and circulates water through the cleaning unit 10, and chemical tank 48. The stop valves 32, 34 are opened allowing the water to be circulated from the chemical tank 48 through the upstream stop valve 32, the upstream circulation hose 24 and the pipe section 14 to be cleaned and returning to the cleaning unit 10 through the downstream valve 20, the downstream stop valve 34 and downstream diversion valve 40 which is positioned as return flow from the pipe section 14. The water flows from the downstream diversion valve 40 through the return flow meter 42 and the return valve 44 and into the chemical tank 48. Pressure and flow rates are optimized with the operating pressure being no greater than the normal operating pressure of the pipe section 14 to be cleaned. This is accomplished by adjusting the bypass valve 64 from a fully open position toward a closed position until the desired pressure and flow rates are achieved. By monitoring each percentage of bypass valve 64 closure versus increase in flow rate at the discharge flow meter 46, optimum flow rate is achieved when there is no increase in discharge flow with continued bypass valve 64 closure.

Once optimum flow rates are established in the mobile cleaning unit and pipe section, circulation hoses as well as all valves, flanges and other components of the unit are checked for leakage. Likewise, the chemical tank fluid level is monitored, the fluid pressure entering and discharging from the pump and the flow meters are monitored for changes for a minimum of preferably 30 minutes. If any leakage in the system is detected, circulation is discontinued and appropriate repairs are made and the system is then reevaluated for leakage.

The treating solution is then introduced to the circulating water by positioning a treating chemical drum (not shown) proximate the chemical injection valve 52. A preferably one inch chemical transfer hose from the drum transfer pump (not shown) to the chemical injection valve 52 is connected and the injection valve 52 is opened to transfer the desired amount of treating solution into the cleaning tank 48. Once this is accomplished, the injection valve 52 is closed and the chemical transfer hose is disconnected.

Preferably, the treating solution is a combination of aqueous solutions of mineral acids such as hydrochloric, nitric, phosphoric, polyphosphoric, hydrofluoric, boric, sulfuric, sulfurous and the like. Aqueous solutions of organic acids

have also been found to be useful as have aqueous mixtures of mineral and organic acids. Specific treating solutions useful with this invention are identified in previously discussed U.S. Pat. No. 5,360,488, which is hereby incorporated by reference, as well as U.S. Pat. Nos. 5,322,635 and 5,451,350, each of which are hereby incorporated by reference and disclose one to one ratio soap compositions.

After the appropriate treating solution is injected into the chemical tank **48** and the system is operating as described without any leaks at the appropriate pressures and flow rates, the treating solution is continued to be circulated in a first direction of arrow A through the pipe section **14** to clean sediment deposits and tuberculated growth within the pipe. The direction of arrow A for the initial circulation of the treating solution is the same as the direction of flow of the water through the pipe section **14** in use. In order to achieve optimum effectiveness and efficiency in cleaning the pipe section **14**, periodically the flow direction of the treating solution is reversed in the pipe section **14** as follows. The bypass valve **64** on the chemical tank **48** is fully opened and the direction of the diversion valves **38**, **40** are adjusted to thereby change the flow through the upstream stop valve **32** from discharge from the cleaning unit **10** to a return direction from the pipe section **14** and the direction of flow through the downstream stop valve **34** from return into the cleaning unit **10** to discharge from the cleaning unit **10** to the pipe section **14** to be cleaned. As a result, the flow direction in the pipe section **14** is in the direction of arrow B, opposite the original flow direction of arrow A and tuberculated nodules and other growth which is accumulated within the pipe section **14** are removed or broken off due to the more turbulent flow in the opposite direction from which they were formed. Specifically, when the flow of the treating solution is reversed in the pipe section **14** to the direction of arrow B which is opposite from the water flow direction when the pipe section is in use, tuberculated growth that has developed directionally with the typical flow direction in the pipe **14** is more easily broken off. Further, the flow direction has been reversed without disconnecting the cleaning unit **10** from the pipe section **14** thereby minimizing downtime of the water distribution network **12** and the labor required for the cleaning process. The system pressures and flow rates are again optimized by adjusting the bypass valve **64** from a fully open position toward a closed position. Monitoring each percentage of bypass valve **64** closure versus increase in flow rate through the discharge flow meter **46** enables an optimum flow rate to be achieved when there is no increase in flow rate as a result of continued bypass valve **64** closure. The direction of flow is preferably repeatedly reversed until the cleaning process in the pipe section **14** is completed.

During the cleaning process with treating solution flow in either direction, the cleaning process is monitored by various methods including discharge and return pressure and flow rates, specific gravity of the treating solution, consumption of the treating solution chemistry such as pH, conductivity or the like, changes in treating solution color and temperature. Further, all cleaning unit fittings as well as valves, pipes and associated components are continuously visually monitored for leakage along with any gain or loss of treating solution volume by monitoring the treating solution level indicator **50** on the chemical tank **48** and/or a sight gage. Further, changes in relative discharge and return flow rates between the meters **46**, **42** is also an indication of any gain or loss of any treating solution volume.

After the pipe section **14** is cleaned, the treating solution is displaced by closing the downstream stop valve **34**. The return, bypass, suction and upstream stop valves **44**, **64**, **58**, **32** are all in opened positions. The upstream diversion valve **38** is positioned as return flow from the upstream direction and the downstream diversion valve **40** is positioned as return flow from the downstream direction. The upstream isolation valve **18** is opened allowing water from the distribution network **12** to displace the treating solution in the upstream circulation hose **24** and the cleaning unit valves and piping and flow into the chemical tank **48**. Preferably the pH of the displaced treating solution is monitored at the flanged swivel adapter **28** on the upstream stop valve **32** until the desired pH reading is achieved. The upstream stop valve **32** and the upstream valve **16** are then closed and the downstream stop valve **34** is opened allowing the system water to flow through the clean pipe section **14** and thereby displacing the treating solution through the downstream circulation hose **26** and the downstream portion of the mobile cleaning unit valves and piping and into the cleaning tank **48**. The flow is monitored until the pH at the flange swivel adapter **30** has returned to the desired pH level at which time the downstream stop valve **34** and the downstream valve **20** are closed. The downstream isolation valve **22** is then opened placing the clean pipe section **14** back into service.

Once the treating solution is displaced from the pipe section **14**, it is preferably neutralized and then discharged. To do so, the pump **56** is started thereby circulating the spent treating solution through the mobile cleaning unit **10**, valves and chemical tank **48**. During the circulation of the spent solution drums of neutralizing solution (not shown) are positioned near the injection valve **52** on the chemical tank **48** and the chemical transfer hose from the drum transfer pump (not shown) to the valve is connected. The injection valve **52** is opened to transfer the neutralizing solution into the chemical tank **48** until the desired pH of the fluid in the chemical tank **48** is achieved. The injection valve **52** is then closed and the chemical transfer hose disconnected. A disposal transfer hose (not shown) is connected to the dump valve **36** to discharge the neutralized treating solution into a predetermined disposal waste stream. The pump **56** is turned off and the drain valve **54** is then opened to empty the balance of the neutralized treating solution from the chemical tank **48** to the waste stream. Once this is accomplished, the circulation hoses **24**, **26** are disconnected from the upstream and downstream valves **16**, **20** and the flanged swivel adapters **28**, **30** and the hoses are rewound onto the hose reels. Preferably, any sediment in the chemical tank **48** is flushed with fresh water from the water tanks (not shown) through the drain valve **54** to a waste stream and the cleaning process is now completed.

A second presently preferred configuration of the mobile cleaning unit **10a** according to this invention is shown in FIG. **2**. The mobile cleaning unit **10a** as shown in FIG. **2** is divided, for purposes of illustration only, into two separate sections, but it will be appreciated by one of ordinary skill in the art that the components of each section can be contained on a single flatbed truck (not shown) or the like for transportation thereof. The components shown in FIG. 2 which have corresponding counterparts to the embodiment shown in FIG. 1 are identified with the same reference numerals and it will be appreciated that the preferred components identified with reference to FIG. 1 are preferably also used with the embodiment of FIG. 2. The upstream circulation hose **24** is connected through the flanged swivel adapter **28** to the upstream stop valve **32** directly to a discharge reversing valve **66** which is adjustable between a return position for flow from the pipe section **14** into the cleaning unit **10a** and a discharge position for flow from the

cleaning unit **10***a* to the pipe section 14. Preferably the discharge reversing valve 66 is a three way, 3 inch valve with wrench and lock-out capability and an auxiliary port. Such a valve is available from Xomox Corporation as Part No. 031 AX DI/PFA. The downstream valve 20 is connected to the downstream circulation hose 26 to a flanged swivel adapter 68 on a valve 70 which is mounted on a secondary chemical tank 72. The secondary chemical tank 72 includes a level indicator 74 and a drain valve 76 similar to the chemical tank 48. Optionally, the secondary chemical tank 72 and valve 70 and components may be mounted only on an auxiliary trailer (not shown) for independent transportation from the chemical tank 48, pump 56 and other components of the mobile cleaning unit **10***a* which are connected to the upstream valve 16.

After the upstream and downstream circulation hoses 24, 26 are connected to the respective valves 16, 20 on opposing ends of the pipe section 14 to be cleaned, the unit **10***a* is charged with water from the distribution network 12 by closing the downstream valve 20, injection valve 52, a dump valve 78, the drain valve 54 on the chemical tank 48, the valve 70 on the secondary chemical tank 72, and drain valve 76 on the secondary chemical tank 72. The upstream, bypass and suction valves 16, 64, 58 and upstream stop valve 32 are all opened and the discharge reversing valve 66 is positioned for return flow into the mobile cleaning unit **10***a* from the upstream direction. When the upstream valve 16 is opened, water from the distribution network 12 enters the upstream circulation hose 24 to displace the air and fill the hose 24 and other components of the cleaning unit connected thereto. The water flows through the mobile cleaning unit **10***a* and fills the chemical tank 48. Once the chemical tank 48 reaches an appropriate level, the upstream stop valve 32 is closed and the downstream valve 20 and valve 70 on the secondary chemical tank 72 are opened allowing water to flow through the pipe section 14 and into the downstream circulation hose 26 to fill the secondary chemical tank 72. The flow is continued until the desired water level in the secondary chemical tank 72 is achieved.

The system is isolated from the remainder of the water distribution network 12 and checked for leaks by closing the upstream and downstream isolation valves 18, 22 and positioning the discharge reversing valve 66 as discharge from the mobile cleaning unit **10***a* to the pipe section 14. With the bypass valve 64 and the return valve 44 closed, the circulation pump 56 is started and water is pumped from the chemical tank 48 through the mobile cleaning unit valves and piping system and upstream stop valve 32 into the upstream circulation hose 24 and through the pipe section 14 to be cleaned. The water flows in a first direction indicated by arrow C through the pipe section 14 and into the downstream valve 20 and through the downstream circulation hose 26 and into the secondary chemical tank 72 until air is purged from the system. The valve 70 on the secondary chemical tank 72 is then closed and pressure on the system is maintained at a level no greater than the normal operating pressure of the water distribution network 12 and the pipe section 14 to be cleaned by adjusting the bypass valve 64 from a full open position toward a closed position as previously described. After the desired pressure is attained, all valves, fittings and other components are checked for leakage as well as the level in the chemical tanks 48, 72 being monitored for any change for a minimum of 30 minutes. If leakage or any change in the fluid level in the chemical tanks 48, 72 can be determined, the system pressure is released and appropriate repairs are made and the system reevaluated.

The treating solution is injected into the chemical tank 48 through the injection valve 52 as previously described with reference to the first preferred embodiment shown in FIG. 1. The treating solution is connected via a chemical transfer hose (not shown) through the injection valve 52 and pumped into the chemical tank 48 and then the chemical transfer hose is disconnected and the injection valve 52 closed. The upstream stop valve 32 and the bypass valve 64 are opened with the pump 56 turned on to mix the treating solution in the chemical tank 48. The treating solution surges through the pipe section 14 in a first direction indicated by arrow C by opening the upstream and downstream valves 16 and 20, the upstream stop valve 32, and the valve 70 on the secondary chemical tank 72 and positioning the discharge reversing valve 66 for discharge from the pump 56 to the pipe section 14. Once again, the cleaning process is monitored as previously described. Periodically and repeatedly the flow direction of the treating solution in the pipe section 14 is reversed in order to achieve a more effective and complete cleaning of the pipe section 14. The treating solution flow direction is reversed when the treating solution in the chemical tank 48 or the secondary chemical tank 72 reaches a predetermined minimum volume as detected by the level indicators 50, 74. The treating solution flow direction is reversed by changing the discharge reversing valve 66 from a discharge orientation to a return orientation and opening the return valve 44 and closing the suction valve 58. As a result, the treating solution flows from the secondary chemical tank 72 in the direction of arrow D through the pipe section 14 and into the chemical tank 48. The flow reversal process is repeated until the cleaning process of the pipe section 14 is completed. Advantageously, the flow reversal is accomplished without disconnecting the mobile cleaning unit components from the pipe section 14 or water distribution network 12.

After the cleaning process is completed, the treating solution is displaced in the following manner. Preferably, the bulk of the treating solution is contained in the chemical tank 48 and the downstream valve 20 on the secondary chemical tank 72, the drain valve 76 on the secondary chemical tank 72, the injection valve 52 and the drain valve 54 on the chemical tank 48 are all in the closed position and the upstream 16, bypass 64, suction 58 and upstream stop 32 valves are all in an open position. The upstream isolation valve 18 is opened allowing water from the distribution network 12 to displace the spent treating solution in the upstream circulation hose 24 and into the mobile cleaning unit valves and piping and ultimately the chemical tank 48. The pH of the displaced solution is monitored at the flanged swivel adapter valve 28 on the upstream stop valve 32 until the desired pH reading is achieved. The upstream valve 16, upstream stop valve 32 and downstream isolation valve 22 are closed and the downstream valve 20 and the valve 70 on the secondary chemical tank 72 and the upstream isolation valve 18 are opened allowing water from the distribution network 12 to flow through the clean pipe section 14 and displace the treating solution in the downstream circulation hose 26 and valves connected to the secondary chemical tank 72. The flow is monitored at the flanged swivel adapter 68 on the valve 70 at the secondary chemical tank 72 until the desired pH level is achieved. The downstream valve 20 and the upstream isolation valves 18 are then closed. The downstream circulation hose 26 is then disconnected at the flanged swivel adapter 68 and the secondary chemical tank 72 and associated components are transported to the chemical tank 48, if appropriate, and the contents of the secondary chemical tank 72 are transferred into the chemical tank 48.

The spent treating solution is then neutralized and disposed of by starting the circulation pump 56 and circulating the spent treating solution through the mobile cleaning unit piping system, valves and chemical tank 48. While circulating the solution in this manner, the neutralization solution is injected into the chemical tank 48 through the injection valve 52 until the desired pH of the fluid in the chemical tank 48 is achieved. With the pump 56 operating, the dump valve 78 is then opened and appropriate transfer hoses connected to the dump valve 78 and the neutralized treating solution in the chemical tank 48 and mobile cleaning unit 10a is discharged to an appropriate waste stream and the pump 56 is shut down. The circulation hoses 24, 26 are then disconnected from the respective flanged swivel adapters 28, 68 as well as the upstream and downstream system valves 16, 20 and if necessary any sediment in the chemical tank 48 is flushed with fresh water and discharged therefrom through the drain valve 54. The circulation hoses are then wound onto the reels and the cleaning process is now complete according to the second preferred embodiment of this system.

A presently preferred embodiment of the flanged swivel adapter 28, 30 or 68 used in the mobile cleaning unit 10 or 10a according to this invention is shown in FIGS. 3 and 4. The adapter 28 is preferably a concentric reducer to increase or decrease the cross-sectional area of the flow path of the solution therethrough depending on the flow direction. Preferably, the adapter 28 changes the flow path from a three inch diameter to a four inch diameter for a more laminar flow through the adapter 28.

The adapter 28 includes a base flange 80 having a plurality of threaded or tapped holes 82 therein for securing the adapter to a valve or other component as required with bolts, screws 84 or other preferably threaded fasteners. Advantageously, the adapter 28 and preferably all other connections between the components in the mobile cleaning unit 10 or 10a are made between mating flanges thereby minimizing, if not eliminating, threaded connections which are exposed to the treating solution within the mobile cleaning unit which may erode or deteriorate after prolonged contact with the treating solution or other chemicals. In a presently preferred embodiment, the flange 80 on the adapter 28 is sized to fit a 3 inch class 150 valve and the holes 82 are drilled and tapped through with one-half inch number 13 bolts. The connection between the adapter 28 and an adjacent member of the cleaning unit 10 or 10a such as the upstream stop valve 32 (FIGS. 1 and 4) for example, is accomplished by inserting each bolt 84 through a hole on the stop valve 32 and into one of the threaded holes 82 on the adapter flange 80. Rotation of the bolt 84 enables the threads on the bolt 84 to mesh with the threads in the hole 82 and draw the adapter 28 and stop valve 32 together forming a tight seal therebetween. A set screw 86 may be inserted into a tap hole to secure the bolts 84 connecting the flange 80 to the adjacent valve 32 or other component and inhibit loosening of the connection as a result of vibration or the like.

An upper collar 88 is rotatably mounted on an end of the adapter 28 opposite the flange 80. The inner circumference of the collar 88 has threads 90 machined thereon for a 4 inch navy thread connection for connecting with the circulation hoses 26 or 24. A circumferential race 92 is formed proximate the lower inner edge of the collar 88 and mates with a corresponding race 94 on the adapter body to capture a plurality of preferably one-quarter inch brass balls 96 which enable the rotation of the collar 88 relative to the adapter body for coupling the circulation hoses 24, 26 thereto. Tabs 98 are provided on the outer surface of the collar 88 to facilitate easy rotation thereof. A set screw 108 is threadably positioned in a hole 110 in the collar 88 to capture the balls 96 in the race 94 which have been inserted therein through the hole 110. Preferably, the adapter 28 and other components of the mobile cleaning unit 10 or 10a are fabricated from acid resistant materials such as brass or the like.

Preferably, a bleed line 100 is threadably secured through an aperture 102 between the flange 80 and the collar 88 on the body of the adapter 28. The bleed line 100 is preferably one-quarter inch brass and includes a quarter inch brass ball valve 104 with brass ball and teflon seat (not shown) but could be an elbow valve or other component within the scope of this invention. The valve 104 is operable between the open and closed position by a pivotal handle 106 projecting upwardly therefrom. The bleed line 100 and valve 104 are advantageously provided to remove a portion of the fluid flowing through the adapter 28 in the mobile cleaning unit 10 or 10a for testing, analysis or the like without disruption, disconnection, or interruption of the cleaning operation of the pipe section 14.

From the above disclosure of the general principles of the present invention and the preceding detailed description of a preferred embodiment, those skilled in the art will readily comprehend the various modifications to which this invention is susceptible. Therefore, we desire to be limited only by the scope of the following claims and equivalents thereof.

We claim:

1. A system for cleaning a pipe section of a water distribution network comprising:

a tank adapted to hold a chemical treating solution;

a pump connected to the tank for circulating the treating solution and water from the distribution network into and from the tank;

an upstream diversion valve being connected to an upstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the upstream end of the pipe section and a return position permitting flow from the upstream end of the pipe section to the system; and

a downstream diversion valve being connected to a downstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the downstream end of the pipe section and a return position permitting flow from the downstream end of the pipe section to the system;

wherein the treating solution can be circulated in a first direction through the pipe section when the upstream and downstream diversion valves are in the discharge and return positions, respectively, and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the upstream and downstream diversion valves are in the return and discharge positions, respectively, so that the treating solution is circulated in a closed-loop path through the system and the pipe section in the first and second directions for increased cleaning effectiveness to remove scale and other sediment within the pipe section.

2. The system of claim 1 further comprising:

a vehicle upon which the system is mounted for transportation.

3. The system of claim 1 further comprising:

an upstream stop valve operably connected between the upstream diversion valve and the upstream end of the pipe section; and

an downstream stop valve operably connected between the downstream diversion valve and the downstream

end of the pipe section, each said stop valve being adjustable between open and closed positions which permit and prevent, respectively, flow therethrough.

4. The system of claim 1 wherein the direction of the circulation of the treating solution is reversed between the first and second directions without disconnecting the system from the pipe section.

5. A system for cleaning a pipe section of a water distribution network comprising:

a tank adapted to hold a chemical treating solution;

a pump connected to the tank for circulating the treating solution and water from the distribution network into and from the tank;

an upstream diversion valve being connected to an upstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the upstream end of the pipe section and a return position permitting flow from the upstream end of the pipe section to the system;

a downstream diversion valve being connected to a downstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the downstream end of the pipe section and a return position permitting flow from the downstream end of the pipe section to the system;

wherein the treating solution can be circulated in a first direction through the pipe section when the upstream and downstream diversion valves are in the discharge and return positions, respectively, and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the upstream and downstream diversion valves are in the return and discharge positions, respectively, for increased cleaning effectiveness to remove scale and other sediment within the pipe section; and

a bypass line connected between the chemical tank and the pump;

a bypass valve operably connected on the bypass line and permitting flow from the pump to the tank, the bypass valve being adjustable to and between an open position and a closed position to permit adjustment of pressure and flow rates within the system.

6. A system for cleaning a pipe Section of a water distribution network comprising:

a tank adapted to hold a chemical treating solution;

a pump connected to the tank for circulating the treating solution and water from the distribution network into and from the tank;

an upstream diversion valve being connected to an upstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the upstream end of the pipe section and a return position permitting flow from the upstream end of the pipe section to the system; and

a downstream diversion valve being connected to a downstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the downstream end of the pipe section and a return position permitting flow from the downstream end of the pipe section to the system;

wherein the treating solution can be circulated in a first direction through the pipe section when the upstream and downstream diversion valves are in the discharge and return positions, respectively, and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the upstream and downstream diversion valves are in the return and discharge positions, respectively, for increased cleaning effectiveness to remove scale and other sediment within the pipe section;

an upstream stop valve operably connected between the upstream diversion valve and the upstream end of the pipe section; and

a downstream stop valve operably connected between the downstream diversion valve and the downstream end of the pipe section, each said stop valve being adjustable between open and closed positions which permit and prevent, respectively, flow therethrough.

a flanged swivel adaptor on each of the stop valves, each said adaptor having a flange on a first end coupled to the stop valve and a threaded collar rotatably mounted on a second end and threadably coupled to a tubular member in communication with the pipe section.

7. The system of claim 6 further comprising:

a bleed line projecting from each adaptor to divert a portion of the fluid flowing through each adaptor;

a valve on the bleed line being adjustable to and between a closed position and an open position which permit and prevent, respectively, flow through the valve.

8. The system of claim 6 wherein said adapter adjusts a flow path cross-sectional area between said first end and said second end.

9. A system for cleaning a pipe section of a water distribution network comprising:

a tank adapted to hold a chemical treating solution;

a pump connected to the tank for circulating the treating solution and water from the distribution network into and from the tank;

an upstream diversion valve being connected to an upstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the upstream end of the pipe section and a return position permitting flow from the upstream end of the pipe section to the system;

a downstream diversion valve being connected to a downstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the downstream end of the pipe section and a return position permitting flow from the downstream end of the pipe section to the system;

wherein the treating solution can be circulated in a path through the system and the pipe section in a first direction when the upstream and downstream diversion valves are in the discharge and return positions, respectively, and the treating solution can be circulated in a path through the system and the pipe section in a second direction opposite from the first direction when the upstream and downstream diversion valves are in the return and discharge positions, respectively, without disconnecting the system from the pipe section, the circulation of the solution in the first and second directions increasing the cleaning effectiveness of the system to remove scale and other sediment within the pipe section;

a bypass line connected between the chemical tank and the pump;

a bypass valve operably connected on the bypass line and permitting flow from the pump to the tank, the bypass valve being adjustable to and between an open position and a closed position to permit adjustment of pressure and flow rates within the system;

an upstream stop valve operably connected between the upstream diversion valve and the upstream end of the pipe section;

an downstream stop valve operably connected between the downstream diversion valve and the downstream

end of the pipe section, each said stop valve being adjustable between open and closed positions which permit and prevent, respectively, flow therethrough; and

a vehicle upon which the system is mounted for transportation.

10. The system of claim 9, further comprising:

a flanged swivel adaptor on each of the stop valves, each said adaptor having a flange on a first end coupled to the stop valve and a threaded collar rotatably mounted on a second end and threadably coupled to a tubular member in communication with the pipe section, wherein said adapter adjusts a flow path cross-sectional area between said first end and said second end;

a bleed line projecting from each adaptor to divert a portion of the fluid flowing through each adaptor; and

a valve on the bleed line being adjustable to and between a closed position and an open position which permit and prevent, respectively, flow through the valve.

11. A system comprising:

a pipe section of a water distribution network;

a primary tank and a secondary tank each being adapted to hold a chemical treating solution;

a pump connected to the primary tank for circulating the treating solution and water from the distribution network into and from each of the tanks;

a reversing valve being connected to one end of the pipe section and being adjustable between a discharge position permitting flow from the primary tank to the pipe section and a return position permitting flow from the pipe section to the primary tank system;

a valve connected to another end of the pipe section and being adjustable between an open position permitting flow between the pipe section and the secondary tank and a closed position inhibiting flow between the pipe section and the secondary tank;

wherein the treating solution can be circulated in a first direction through the pipe section when the reversing valve is in the discharge position and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the reversing valve is in the return position for increased cleaning effectiveness to remove scale and other sediment within the pipe section.

12. The system of claim 11 wherein the direction of the circulation of the treating solution is reversed between the first and second directions without disconnecting the system from the pipe section.

13. A system for cleaning a pipe section of a water distribution network comprising:

a primary tank and a secondary tank each being adapted to hold a chemical treating solution;

a pump connected to the primary tank for circulating the treating solution and water from the distribution network into and from each of the tanks;

a reversing valve being connected to one end of the pipe section and being adjustable between a discharge position permitting flow from the primary tank to the pipe section and a return position permitting flow from the pipe section to the primary tank system;

a valve connected to another end of the pipe section and being adjustable between an open position permitting flow between the pipe section and the secondary tank and a closed position inhibiting flow between the pipe section and the secondary tank;

wherein the treating solution can be circulated in a first direction through the pipe section when the reversing valve is in the discharge position and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the reversing valve is in the return position for increased cleaning effectiveness to remove scale and other sediment within the pipe section;

a first flanged swivel adaptor between the reversing valve and the pipe section and a second flanged swivel adaptor between the secondary tank and the pipe section, each said adaptor having a flange on a flange on a first end and a threaded collar rotatably mounted on a second end and threadably coupled to a tubular member in communication with the pipe section;

a bleed line projecting from each adaptor to divert a portion of the fluid flowing through each adaptor; and

a valve on the bleed line being adjustable to and between a closed position and an open position which permit and prevent, respectively, flow through the valve.

14. A cleaning system comprising:

a pipe section of a water distribution network, the pipe section having an upstream end and a downstream end;

a tank adapted to hold a chemical treating solution;

a pump connected to the tank for circulating the treating solution and water from the pipe section into and from the tank;

an upstream diversion valve being connected to the upstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the upstream end of the pipe section and a return position permitting flow from the upstream end of the pipe section to the system; and

a downstream diversion valve being connected to the downstream end of the pipe section and being adjustable between a discharge position permitting flow from the system to the downstream end of the pipe section and a return position permitting flow from the downstream end of the pipe section to the system;

wherein the treating solution can be circulated in a first direction through the pipe section when the upstream and downstream diversion valves are in the discharge and return positions, respectively, and the treating solution can be circulated in a second direction through the pipe section opposite from the first direction when the upstream and downstream diversion valves are in the return and discharge positions, respectively, for increased cleaning effectiveness to remove scale and other sediment within the pipe section.

15. The cleaning system of claim 14 further comprising:

a bypass line connected between the chemical tank and the pump; and

a bypass valve operably connected on the bypass line and permitting flow from the pump to the tank, the bypass valve being adjustable to and between an open position and a closed position to permit adjustment of pressure and flow rates within the system.

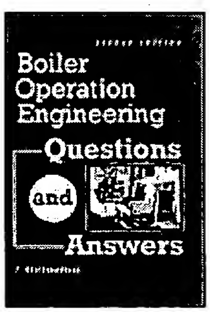
16. The cleaning system of claim 14 further comprising:

an upstream stop valve operably connected between the upstream diversion valve and the upstream end of the pipe section; and

a downstream stop valve operably connected between the downstream diversion valve and the downstream end of the pipe section, each said stop valve being adjustable between open and closed positions which permit and prevent, respectively, flow therethrough.

* * * * *

Saturated Steam Tables



Saturated Steam Tables

Saturated Steam
Pressure in Absolute PSI

Abs press (psia) lb per in²	Temp °F	Specific volume ft³ / lbm		Enthalpy		Entropy btu / lbm × °F		Abs press (psia) lb per in²
		Water V_f	Steam V_g	Water h_f	Steam h_g	Water S_r	Steam S_g	
0.08865	32.018	0.016022	3302.4000	0.0003	1075.5	0.0000	2.1872	0.08865
0.250	59.323	0.016032	1235.5000	27.382	1067.4	0.0542	2.0967	0.250
0.500	79.586	0.016071	641.5000	47.623	1096.3	0.0925	2.0370	0.500
1.000	101.74	0.016136	333.6000	69.730	1105.8	0.1326	1.9781	1.000
3.000	141.47	0.016300	118.7300	109.420	1122.6	0.2009	1.8864	3.000
6.000	170.05	0.016451	61.9840	138.030	1134.2	0.2474	1.8294	6.000
10.000	193.21	0.016592	38.4200	161.260	1143.3	0.2836	1.7879	10.000
14.696	212.00	0.016719	26.7990	180.170	1150.5	0.3121	1.7568	14.696
15.000	213.03	0.016726	26.2900	181.210	1150.9	0.3137	1.7552	15.000
20.000	227.96	0.016834	20.0870	196.270	1156.3	0.3358	1.7320	20.000
25.000	240.07	0.016927	16.3010	208.520	1160.6	0.3535	1.7141	25.000
30.000	250.34	0.017009	13.7440	218.900	1164.1	0.3682	1.6995	30.000
35.000	259.29	0.017083	11.8960	228.000	1167.1	0.3809	1.6872	35.000
40.000	267.25	0.017151	10.4965	236.100	1169.8	0.3921	1.6765	40.000
45.000	274.44	0.017214	9.3988	243.500	1172.0	0.4021	1.6671	45.000
50.000	281.02	0.017274	8.5140	250.200	1174.1	0.4112	1.6586	50.000
55.000	287.08	0.017329	7.7850	256.400	1175.9	0.4196	1.6510	55.000
60.000	292.71	0.017383	7.1736	262.200	1177.6	0.4273	1.6440	60.000
65.000	297.98	0.017433	6.6533	267.600	1179.1	0.4344	1.6375	65.000
70.000	302.93	0.017482	6.2050	272.700	1180.6	0.4411	1.6316	70.000
75.000	307.61	0.017529	5.8144	277.600	1181.9	0.4474	1.6260	75.000
80.000	312.04	0.017573	5.4711	282.100	1183.1	0.4534	1.6208	80.000
85.000	316.26	0.017617	5.1669	286.500	1184.2	0.4590	1.6159	85.000
90.000	320.38	0.017659	4.8953	290.700	1185.3	0.4643	1.6113	90.000
95.000	324.13	0.017700	4.6514	294.700	1186.2	0.4694	1.6069	95.000
100.000	327.82	0.017740	4.4310	298.500	1187.2	0.4743	1.6027	100.000
105.000	331.37	0.01778	4.2309	302.200	1188.0	0.4790	1.5988	105.000
110.000	334.79	0.01782	4.0306	305.800	1188.9	0.4834	1.5950	110.000
115.000	338.08	0.01785	3.8813	309.300	1189.6	0.4877	1.5913	115.000
120.000	341.27	0.01789	3.7275	312.600	1190.4	0.4919	1.5879	120.000
125.000	344.35	0.01792	3.5857	315.800	1191.1	0.4959	1.5845	125.000
130.000	347.33	0.01796	3.4544	319.000	1191.7	0.4998	1.5813	130.000
135.000	350.23	0.01799	3.3325	322.000	1192.4	0.5035	1.5782	135.000

140.000	353.04	0.01803	3.2010	325.000	1193.0	0.5071	1.5752	140.000
145.000	355.77	0.01806	3.1130	327.800	1193.5	0.5107	1.5723	145.000
150.000	358.43	0.01809	3.0139	330.600	1194.1	0.5141	1.5695	150.000
160.000	363.55	0.01815	2.8386	336.100	1195.1	0.5206	1.5641	160.000
170.000	368.42	0.01821	2.6738	341.200	1196.0	0.5269	1.5591	170.000
180.000	373.08	0.01827	2.5312	346.200	1196.9	0.5328	1.5543	180.000
190.000	377.53	0.01833	2.4030	350.900	1197.6	0.5384	1.5498	190.000
200.000	381.80	0.01839	2.2873	355.500	1198.3	0.5438	1.5454	200.000
210.000	385.91	0.01844	2.18217	359.900	1199.0	0.5490	1.5413	210.000
220.000	389.88	0.01850	2.08629	364.200	1199.6	0.5540	1.5374	220.000
230.000	393.70	0.01855	1.99846	368.300	1200.1	0.5588	1.5336	230.000
240.000	397.39	0.01860	1.91769	372.300	1200.6	0.5634	1.5299	240.000
250.000	400.97	0.01865	1.84317	376.100	1201.1	0.5679	1.5264	250.000
260.000	404.44	0.01870	1.77418	379.900	1201.5	0.5722	1.5230	260.000
270.000	407.80	0.01875	1.71013	383.600	1201.9	0.5764	1.5197	270.000

pounds per square inch absolute (psia) = pounds per square inch gauge (psig) + 14.7 psi

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